A sedimentary high-energy wave record from Narragansett Bay, Rhode Island

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INTRODUCTION

Storm surges are high-energy wave events that can overtop beach-barrier dunes; removing sediments from nearshore environments and depositing overwash fans across protected low-energy back-barrier systems, (e.g., coastal marshes, ponds, and lagoons). Analyses of overwash records improve our understanding of coastal hazards by providing insight into recurrence intervals that cannot be identified from the short instrumental and written record. At Fox Hill salt marsh, anomalous sand deposits were mapped by hand augering throughout the ~0.13km2 back-barrier system. Stratigraphic analyses reveal that 11 overwash fans have been deposited over the past ~1000 years. Historical records indicate that five high-energy waves events capable of producing overwash deposits have been observed in southern Rhode Island: AD 1954, 1938, 1815, 1638 and 1635. The five shallowest overwash sands at Fox Hill are most likely the result of each of these historical storms. At Succotash marsh, 17 km to the southwest of Fox Hill marsh, two pre-historic overwash sand deposits date to AD 1404-1446 and 1295-1407. We also identify these overwash deposits at Fox Hill and present new geologic evidence for a further three older overwash deposits dating from AD 1170-1256, 1041-1165, and 1025-1154. The Fox Hill marsh overwash record not only corroborates the existing geological record of high-energy wave events in Rhode Island but also extends our understanding of coastal hazards in southern New England, USA by extending the Succotash marsh record.

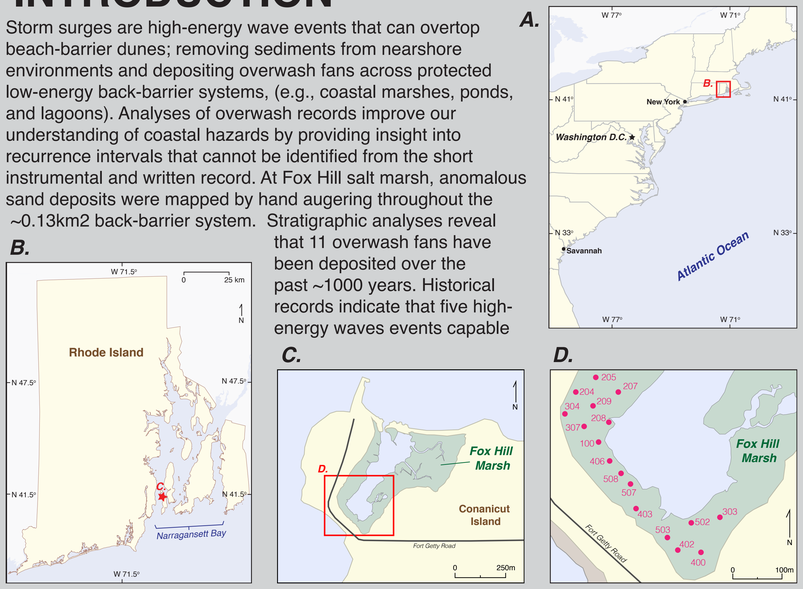


Figure 1. A) Location map of the northeastern coast of the United States. B) Location Map of Rhode Island, USA. C) Location map of Fox Hill Marsh. D) Core locations (pink dots) map.

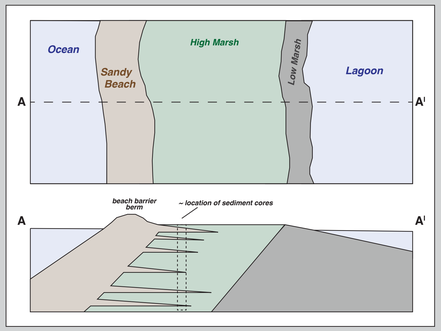


Figure 2. Hypothetical schematic cross section of high-energy wave deposites in a back barrier setting. Modified after Donnelly et al., 2001.

METHODS

Stratigraphy was mapped across 17 locations throughout the southern section of marsh using hand auger coringing techniques. Representative stratigraphic sections were selected for computerized tomography (CT) scaning (Rhode Island South County Hospital), AMS radiocarbon dating (NOSAMS) and grain-size analysis (URI Sea Level Research Lab).

Figure 3. Pictures showing citizen scientists/ Earthwatch students, A) hand coring, B) des-cribing stratigraphy, C) selecting representative cores, D) & E) selecting plant macrofossils to date.

STRATIGRAPHIC CORRELATION

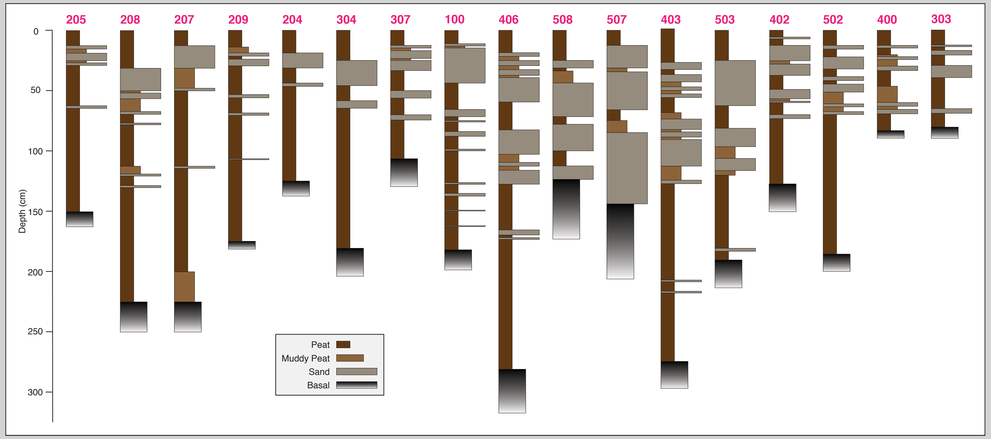


Figure 4. Overwash stratigraphy at Fox Hill salt marsh.

STRATIGRAPHIC ANALYSIS

Computerized Tomography

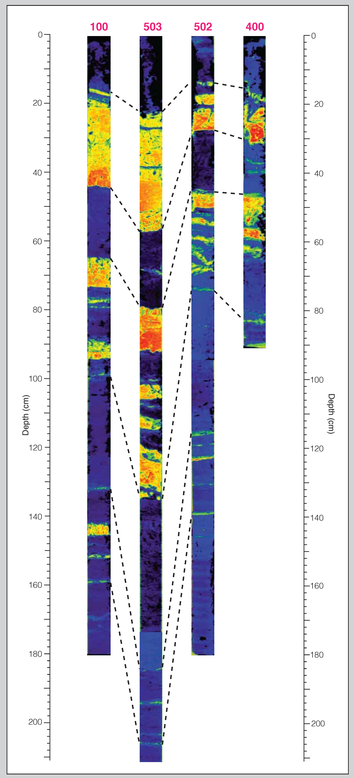


Figure 5. CT imagery of representative cores. Cool colors = less dense & warm = more dense

AMS Radiocarbon dating

Figure 6. Pictures plant macrofossils A) 47.5, B) 87.5, C) 122.5, D) 135.5

Table 1. Summary of Fox Hill Marsh radiocarbon ages

Latitude (°N, decimal degrees)	Longitude (°W, decimal degrees)	Lab identifier	Sample description	Lab-reported age (^{13}C yr BP at 1σ)	Calibrated age range (cal yr BP at 2σ)	Calibrated age range (cal AD)	Provenance interpretation
41.488833	71.398202	FHM.17.100.A.47.5	rhizome	230±15	215-245	1647-1950	Maximum
41.488833	71.398202	FHM.17.100.A.79	rhizome	185±15	170-200	1655-1950	Maximum
41.488833	71.398202	FHM.17.100.A.87.5	woody stem	140±15	125-155	1675-1941	Maximum
41.488833	71.398202	FHM.17l100.A.92	woody stem	320±25	295-345	1488-1644	Maximum
41.488833	71.398202	FHM.17.100.A.122.5	rhizome	650±20	630-670	1284-1390	Maximum
41.488833	71.398202	FHM.17.100.A.135.5	woody stem	830±15	815-845	1170-1256	Maximum
41.488833	71.398202	FHM.17.100.A.142.5	rhizome	910±15	895-925	1041-1165	Maximum
41.488833	71.398202	FHM.17.100.A.150	rhizome	950±20	930-970	1025-1154	Maximum

Grain-size analysis

Interbedded sand deposits, found beneath the modern marsh surface at the FHM.100 core location, display unique grain-size distributions. Shallower sands have coarser particle size classes and resemble the modern beach grainsize distribution. Deeper over-wash deposits have finer particle size distributions. Grain size analysis of over-wash deposits found at other core locations are needed to confirm the con-sistency of this trend.

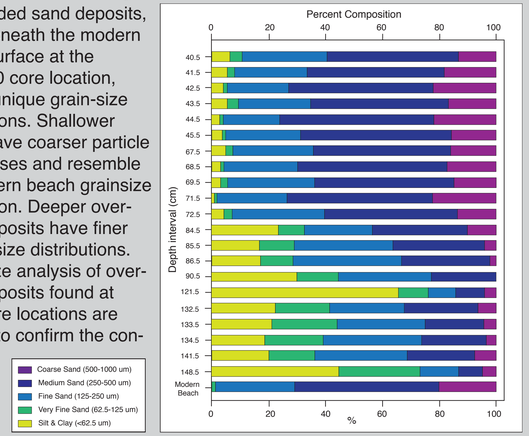
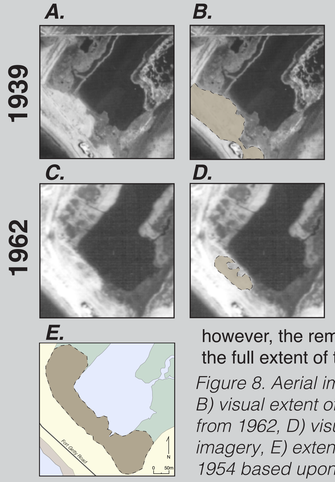


Figure 7. Preliminary grain size distribution of overwash deposits.

AERIAL IMAGERY



Aerial imagery can provide an additional line of evidence of over-wash deposits. In 1938, a catergory 3 hurricane directly hit the Rhode Island coast. Less than one year later a statewide aerial photographic campaign captured images of the remnant deposit (Figure 8. A&B). Similarly, in 1954, hurricane Carol also hit Rhode Island although, the next statewide aerial photo-graphic campaign did not occur untill 1962 (Figure 8. C). In both the 1939 and 1962 images a deposit is visible (Figure 8. B&D) however, the remnant deposits do not represent the full extent of the deposits.

Figure 8. Aerial images of Fox Hill marsh; A) from1939 B) visual extent of 1938 deposit based on imagery C) from 1962, D) visual extent of 1954 deposit based on imagery, E) extent of overwash deposits from 1938 and 1954 based upon stratigraphic mapping and analysis.

REGIONAL CORRELATION

Only if the morphological and hydrodynamic characteristics of two estuaries are similar would one expect synchronous sedimentary responses to rising sea level. Fox Hill and Succotsh marshes share such character-istics however, Fox Hill marsh archives a longer sedimentary record (Figure 9). If suitable material is available within the stratigraphic record then AMS radiocarbon dating methodologies may provide the neccessary precision to distinguish overwash deposits regionally.

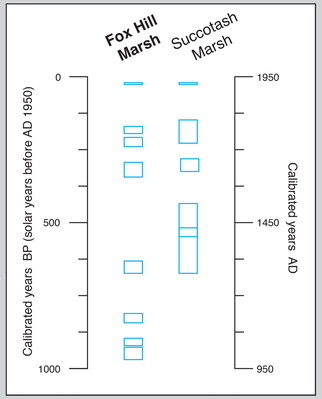


Figure 9. Comparison plot of radio-carbon ages of plant material found directly beneath overwash deposits.

CONCLUSIONS

- At least 9 and as many as 11, high-enery wave events have occured over the past ~1000 years on Conanicut Island, Rhode Island.

- Fox Hill marsh overwash record can potentially corroborate and extend the Succotash marsh record of past high-energy wave events.

ACKNOWLEDGEMENTS

This project was partially funded by the NSF-IUSE-GEOPATHS Award #1540719. We are grateful to South County Hospital for the CT imagery and the National Audubon Society for granting us access to thier property. We also thank the 2017 Earthwatch 'Southern Rhode Island' participants and Matthew Gerlach for all of their hard work.

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